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Asnæs Havnemark: A Late Mesolithic Ertebølle coastal site in western Sjælland,
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Abstract

Archaeological material was initially discovered in 1993, eroding from a small cliff on the north side of the peninsula of Asnæs near the town of Kalundborg in western Sjælland, Denmark. The cultural layer contained flint and pottery diagnostic of the Ertebølle period in the late Mesolithic. Excavations in 2007 were intended to expose the cultural layer and obtain materials to describe the site and its contents before it was destroyed by the sea. The 22 m² of careful excavations exposed a terrestrial midden deposit and the cultural layer which had been partially preserved under a raised beach ridge along the coast, but largely destroyed by older erosion and beach ridge formation in this area. The site itself sits on top of beach ridge materials and the moraine clay and was subsequently covered by later beach ridge deposition. The combination of water screening and fine mesh sieving provided a good sample of the contents of the site. The flint tools consist primarily of projectile points, flake axes, some distally concave truncated blade knives, and a very few scrapers. There were large numbers of well-preserved faunal remains including bone fishhooks and preforms, seal bones, large bird bones, and an extraordinary amount of fish bone. A quantity of pottery was recovered in the excavations as well, including both pointed-bottom vessels and oval lamps in different sizes from the late Mesolithic and several examples of what are probably Early Neolithic ceramics. The rich occupation layer with its diverse artifactual content, including a fragment of a human jaw, documents a sizable residential settlement on the north coast of the Asnæs peninsula.

Keywords

Southern Scandinavia, Stone Age, Mesolithic, Early Neolithic, Funnel Beaker, Holocene, fish

Introduction

The west Sjælland town of Kalundborg sits at the head of a lovely fjord that extends for more than 10 km between the two peninsulas of Røsnæs to the north and Asnæs to the south (Figure 1). The fjord is one of the deepest in eastern Denmark and has been attractive for human settlement for millennia. There are many prehistoric sites reported in the National Register (*Sognebeskrivelse*), more than 100 barrows from the Bronze Age, along with substantial remains from the Mesolithic and Neolithic on the peninsula of Asnæs. Asnæs is also well known as a source of very good flint raw material along the beaches, particularly at its west end.

Figure 1. The location of the site of Asnæs Havnemark toward the tip of the peninsula of Asnæs near the town of Kalundborg, Denmark, looking east. The red arrow marks the site.

The site of Asnæs Havnemark was discovered in 1993 eroding from a small cliff on the north side of the peninsula of Asnæs by amateur archaeologist Egon Iversen. A visit in 2005 confirmed the location of the site and the threat of continued erosion. The cultural layer contained flint, bone, and pottery diagnostic of the Ertebølle period. A radiocarbon date was obtained on a sample of bone and provided a date of 4330 - 4040 cal BC (details of ^{14}C dating are to be found in the Supplementary Material for this article). A heavy winter storm in 2006 further eroded the cliff face, exposed more material, and reiterated the danger that the site faced.

The site is named Asnæs Havnemark and its full designation in the Danish national catalog system (*Sognebeskrivelse*) is Årby sogn, Ars herred, Holbæk amt. Stednr. 030110-365 (KUAS j.nr), or Årby 365 for short. The site is located on a small high point along the north coast that remains as a slight bulge along the coastline (Figure 2). Excavations took place over five weeks in June and July 2007, intended to determine the extent of the site, expose the cultural layer where it was present, and obtain materials to describe the site and its contents before it was completely destroyed by the sea. The excavations exposed a terrestrial midden deposit and cultural layer that were protected and preserved under a raised beach ridge along the coast, but largely destroyed elsewhere by older erosion and continuing beach ridge formation in this area. The site itself sits on top of beach ridge deposits and moraine clay and was subsequently covered by later beach ridge materials. Significant finds at the site included substantial quantities of fish bone and other

faunal remains, fishhooks, and a number of medium size pot sherds from typically thick and heavily tempered Ertebølle ceramics. There were also some unexpected finds discussed below.

Figure 2. LIDAR image of the location of Asnæs Havnemark along the north coast of the Asnæs peninsula.

This study is intended to provide an introduction to the site and our findings and some interpretation of the activities that characterized this place during the Late Mesolithic. The major lesson that we learned from these excavations concerned the variation that defined the settlements and activities of Late Mesolithic groups.

The organization of this essay follows standard practice. The location and setting of the site are provided, followed by some information on the excavations. Site stratigraphy and dating are discussed in the online Supplementary Information. Various categories of finds are then documented including features, flaked flint, pottery, fish and faunal remains, and worked bone. This study ends with some conclusions regarding the site and the implications of these findings for understanding the Mesolithic and the beginning of the Neolithic.

Location and Setting

The landscape of the peninsula is dominated by the end moraine that is Asnæs and the sea which is gradually changing the shape of the peninsula. The sea erodes and builds along the coast — this process has been going on for millennia. The archaeological site of Asnæs Havnemark (Årby 365) is in fact in an active area of modern beach ridge construction. It appears that the Mesolithic settlement was directly on an ancient beach ridge in this area and that there were at least two episodes of occupation. The major focus of our project was the cultural layer that was exposed by wave erosion on the north coast of Asnæs, but we also uncovered a deeper settlement layer at the same place just on top of the moraine surface (described in more detail in the Supplementary Material).

In the early Holocene, the area of the Kalundborg fjord would likely have been dry land, a long valley out the fjord into the river that would become the Storebælt (the Great Belt, the waters connecting the Baltic and Kattegat between the islands of Funen and Sjælland). As sea levels rose during this period, the area was gradually

inundated by a series of transgressions during the Atlantic and early Subboreal periods (e.g., Iversen 1937, Berglund 1971, Christensen 1994, 1995. Christensen, Fischer, and Mathiassen 1997, Jakobsen 1981, 1983, Jessen 1937). As the seas reached higher and the area flooded, a fjord was created in this narrows between Asnæs and Røsnæs. Maximum sea level in this area was probably +2.0 - 2.5 moh (asl) according to Mertz (1924) and our own observations at the site. The end of the Asnæs peninsula may have been inundated, leaving only a few higher, small islands for human occupation. The deep waters of the fjord and the sea of the Storebælt created a rich environment for Mesolithic hunter-gatherers. In all probability, large runs of eels, herring, and other species of fish passed along the coast of Asnæs, as is known to have been the case in historical and modern times (Pedersen 1997).

Excavations

We began field work at Asnæs Havnemark in early June of 2007 by relocating the cultural materials eroding from the sea cliff and orienting our site grid to that cliff. The site grid is 14° W of North. We laid out a 10 square meter grid across the site and adjacent field to provide complete coverage for our excavations and finds. The site grid was given an arbitrary 100N/100E start. We used the southwest corner of excavation units for designation of meter squares. We placed a fixed point on the top of a deeply buried red wooden stake on the west side of a fence post at UTM coordinates 622680/6171480. The top of the stake was 3.188 m moh (asl). The elevation for the site was obtained by collating the results of two methods: an estimate from the mean tidal height and a surveyed transect from a geodetic fixed point at a residence on the peninsula. From the transect we calculated an elevation of 3.187 which corresponded almost exactly with the sea level measurement and which we used as the site fixed point. The UTM coordinates for the site are 622601/6171516 Zone 3.

An elevation map was made of the part of the agricultural field in which we were located (Figure 3). We began a program of hammer coring to map subsurface layers, but this was largely unsuccessful because of all the stones in the beach ridge deposits and the difficulty of recognizing the cultural layer away from the coastline. We then turned to 1 meter square test pits and excavated 6 tests south of

the coastline in order to determine if the cultural layer continued to the south and what the depth and contents of this layer might be. The two southern most tests reached moraine subsoil within 30-40 cm indicating that there was no cultural layer and few artifacts on this surface. A test pit to the east also contained little cultural material, but a distinct series of beach ridge deposits. It is clear that to the east there are more beach deposits. Apparently beach ridges have been accumulating in this area for millennia. The analysis of the test pit contents suggested that the cultural layer was largely preserved to the north under the raised beach ridge. This was the material eroding along the sea cliff at Asnæs Havnemark.

Figure 3. Schematic plan of excavations at Asnæs Havnemark including grid and elevations for the general area of the project.

After some consideration of the test pit data, we used a backhoe to open a north-south trench (Trench 1) near TP1 (Figure 4). This trench was 2 m wide as excavated by the machine. We then moved approximately 10 m east and excavated a second north-south trench (Trench 2) through the deposits with a similar width. Both trenches were begun to the north, as close as possible to the raised beach ridge that marks the border of the landscape here. Artifacts were collected and sections were drawn to record the finds and context, but we were still searching for the cultural layer which appeared in the north ends of Trenches 1 and 2. A subsequent excavation unit, Trench 3, was dug, running east-west across the Trench 1 and 2 units to uncover these deposits. This excavation by machine removed the raised beach ridge deposits along the coast that had protected the cultural layer from earlier erosion and destruction.

Figure 4. Plan of the excavation trenches at Asnæs Havnemark 2007 with shaded meter squares marking the area of intensive excavation.

Careful and intensive excavation was undertaken in the cultural layer in Trench 3 and a total of 22 m² were excavated with water sieving of all deposits (Figure 5). Details of recovery methodology are given in the supplemental material. The excavated squares are shown in Figure 4. This strategy allowed us to obtain a longitudinal sample of the occupation horizon defined by the cultural layer. Sections were drawn in a number of the squares in order to record the stratigraphy and a longitudinal section of Trench 3 was drawn along the south wall of the trench. The estimated extent of the settlement, at least the area of remaining cultural layer, is

indicated in Figure 4 by the yellow zone. Meticulous recovery of fish remains was focused on three squares as indicated in Figure 4, with some fish bones recovered from other squares as well.

Figure 5. Overview of excavations in Trench 3 looking east.

The stratigraphy of the site documented a mix of terrestrial and marine deposits that comprise a base of ground moraine beneath a series of episodes of marine beach ridge formation along this coast. The radiocarbon dates in general confirm a Late Mesolithic date and fit with the archaeological material we recovered. There appear to be two groups of dates, an older pair around 4500 cal BC and a series of nine between 4300 and 4000 cal BC that date the primary cultural layer. Several of the dates appear to overlap the transition to the Neolithic around 4000 cal BC. Details of both site stratigraphy and radiocarbon dating can be found in the Supplementary Information for this article.

Features

A total of ten features were designated in the excavations at Asnæs Havnepark. These features were photographed, drawn, cross-sectioned, and sampled. These features consisted either of a pit or a group of stones distinctive in either number or arrangement. Most of these small pits were generally nondescript. No large structures or graves were encountered in our excavations. There was a probable Bronze Age cooking pit uncovered at the west end of the excavations, probably part of a linear arrangement of such pits that are a characteristic feature of the Bronze Age. Evidence of at least three such pits were observed in our excavations.

Flint

There were more than 320 kg of flint artifacts excavated at the site, a total of 45202 pieces. There were 4992 burned pieces, 31747 flakes, 2996 blades, of which approximately 1350 were produced using a hard hammer. There were 264 flake cores, 18 blade cores, 49 retouched flakes, 12 blade knives (Figure 6), 284 projectile points (Figure 7) and 33 point preforms, 110 flake axes (Figure 8), only 2 core axes neither of which were specialized, and 10 blade scrapers. Core axes, if that is what they are, were poorly made, typical of late Ertebølle. The flint tools

consist primarily of projectile points, flake axes, some distal concave truncated blade knives, a very few scrapers, and a very few possible burins.

Flint from the site is all shapes and sizes and many shades — mostly gray, but there is also some brown material from the deeper cultural layer in Trench 2 that appears lighter than the rest, perhaps due to carbonate accumulation on the flint. Marine patination is minimal in most layers/squares. Very few hammer stones were noted during the excavation. There were many small flakes that indicate flint working at the site. Perhaps the rough preparation of artifacts took place near the sources of flint elsewhere on the peninsula and only finer, finish flaking was done on site at Asnæs Havnemark. The Asnæs peninsula has lots of high-quality flint, particularly at the west end of the peninsula, so that availability is in part responsible for the massive amounts of flint present at the site. My (TDP) impression is that there were more blades at other sites we have excavated, but perhaps the quantity of flint débitage is so much greater here that it masks the importance of blades.

The flint generally is very fresh and sharp. At the same time, some flint materials from the Upper Beach Ridge deposit are wind polished, rolled with worn and fractured edges and slightly marine patinated. This material gives the appearance of having been in the water briefly and having rolled with other stone objects. This material is probably either from the primary occupation at Asnæs Havnemark that was eroded from former coastline to the north or from the earlier occupation horizon that is buried deeply in Trench 2. Some of the layers in some of the squares show a good bit of burning in the flint (and bone) which appears as lots of broken, burned, gray pieces along with much more color including a reddish tint to many pieces which must have been heated.

The projectile points (Figure 7) seem largely to fit Vang Petersen's (1984) Stationsvej phase, but there are a number of exceptions suggesting that this chronological ordering of late Mesolithic projectile points does not work quite so well in western Zealand. Further study of the preforms for projectile points (blade segments vs. flakes and cortical pieces) and the flake axes (or "Havnelevøkser" or small pointed base axes that are more common in the Early Neolithic) may help document connections with the Early Neolithic. More detailed study of the flint artifacts will continue.

Figure 6. A distal concave truncated blade knife from Asnæs Havnemark (Årby 365).

Figure 7. Selected projectile points from various contexts at Asnæs Havnemark (Årby 365).

Figure 8. Selected flake axes from Asnæs Havnemark (Årby 365).

Ceramics

Ceramic vessels are seen in the later Ertebølle in southern Scandinavia after around 4800 cal BC. Early ceramics in northwestern Russia and Finland predate the ceramics in the Ertebølle and closely resemble them technologically (Hartz et al. 2012). It now seems clear that ceramic technology spread from east to west along several routes, one of which appears to have been across northern Eurasia (Hallgren 2008). Early Neolithic ceramics known as Funnel Beaker pottery appear to have their beginnings in the pottery of Central Europe, probably in the Michelsberg culture (Sørensen 2015) and replace Ertebølle ceramics after 4000 cal BC.

Traditional distinctions between the coarse Ertebølle and finer Early Neolithic pottery have focused on shape, construction and decoration. There are changes from a pointed bottom to a flat or slightly rounded bottom, from large grains of temper and thick walled pottery to a finer temper in thin walled vessels, and from limited decoration such as finger impressions around the rim to elaborate patterns made by cord marking and stick impressions around the neck and shoulder. Decoration is rare in the earliest phases of TRB, limited largely to the area below the rim. Decoration of the vessel body became more common and elaborate between 3500 and 3000 cal BC, often with numerous vertical incisions.

There are two forms in the Ertebølle, pots and lamps; the early TRB inventory contained seven forms of ceramic artifacts, including beakers, slender and broad bowls, flasks, lugged amphorae, spoons, and flat discs (Grohmann 2010). A wide range of sizes are known from both periods. Differences are seen in cooking use of pottery from the two periods; only TRB vessels were used in ritual depositions. While the general characteristics of these two traditions are quite different, it is another matter to consistently distinguish small body sherds from excavations, unless they have very diagnostic features.

The overwhelming part of the pottery from the site appears to belong to the Ertebølle pottery tradition. It was our sense that there was a good deal of pottery at Asnæs Havnemark compared to other Mesolithic sites we had excavated. There were ca. 300 sherds both collected and excavated from the site. However, the ceramic material was complex and often difficult to classify. Due to fragmentation, little diagnostic information was available on the shape and size of many of the vessels and distinction between Ertebølle and TRB was often not possible. The description and analysis of the ceramic materials from Asnæs Havnemark was undertaken by Anne Birgitte Gebauer in consultation with Eva Koch, Anders Fischer, and Aikaterini Glykou (Pers. Comm. 2008). The pottery came from two sources. A small group of sherds was collected by Iversen who originally found the site and donated his collection to the museum. The Iversen collection, less than 20 sherds, includes only Ertebølle pottery. In addition to the pottery, two very small pieces of fired daub, one with stick impressions and one with some reddish color, were found in the cultural layer.

A much larger group of sherds came from the 2007 excavations, approximately 275 pieces. The overwhelming part of the pottery from the site appears to belong to the Ertebølle tradition. Most of the pottery consists of body sherds with a thickness between 1.0-1.5 cm. Fragments of pointed bottoms were found in three excavation meter squares (Figure 9). An Ertebølle rim sherd with a diameter ca. 20 cm was found nearby. This rim sherd and one of the base fragments clearly came from larger vessels. Another sherd appears to be part of a small vessel with a diameter of only ca. 8 cm. Heat spalling typical of Ertebølle pottery was seen on the surface of several body sherds.

Figure 9. Round base of Ertebølle vessel. The label provides a scale, the site name, the meter square provenience, and the layer name.

Fragments of Ertebølle clay lamps were found in three squares. One fragment had a greyish brown color on the outside, while the inside was covered with a black crust. Another lamp was represented by 3 rim sherds that fit together (this group measured 5.2 cm in width, 2.1 cm in height and was 1.0-1.1 cm thick) and three body sherds. The rim was turned slightly inwards; finger impressions had been made in the smoothed edge of the rim. The third lamp fragment had a rather uneven surface and a clear bend in the side wall. The rim of this lamp fragment

was turned inwards, the edge was smoothed and decorated with oblique strokes. The second and the third lamp sherds might be from the same piece?

Sherds clearly belonging to the Funnel Beaker tradition were found in a number of squares. This TRB classification was confirmed by Eva Koch and Anders Fischer. The sherds seem to represent a total of six or more different vessels of small to medium or unknown size. These fragments included a rim sherd with possible traces of decoration, a single vessel represented by 3 concave neck sherds with a total diameter ca. 24 cm, a sherd showing a clear, sharp angle between neck and belly (Figure 10), a number of body sherds and a flat bottom sherd, two rim sherds from a small vessel, possibly a Funnel Neck beaker with rim diameter ca. 12 cm, and another rim sherd from a thin-walled vessel with impressions probably made with finger nails in the upper edge of the rim. In addition there were two sherds with oblique coil construction that are TRB in origin, several sherds with worn edges that are generally less than 1 cm in thickness and appear to be Funnel Beaker tradition. There is a large convex belly sherd 3.4 x 2.7 cm in size as well as a concave neck sherd with oblique construction and traces of oblique imprints from rim decoration belonging to the TRB. The general absence of decoration fits well with an early TRB date for this pottery.

Figure 10. TRB pottery sherd, neck-belly transition. The label provides a scale, the site name, the meter square provenience, and the layer name.

Some ceramics from the excavations were examined chemically in two different studies. One of these involved strontium isotope ratios and the other employed Instrumental Neutron Activation (INAA or NAA) to characterize some of the pottery. This aspect of our study is reported in the online Supplementary Information. In sum, the chemical composition of the Funnel Beaker pottery is indistinguishable from the Ertebølle ceramics.

Nutshell

Burned hazelnut shell was observed in the excavations and in the water-screened material from the site, but was not abundant and could not be systematically collected or counted. Its presence is simply noted here. Such burned nutshell has been reported as very common at some Mesolithic sites such as Smakkerup Huse

in Denmark (e.g., Price and Gebauer 2005) and Duvensee in northern Germany (Bokelmann 2012) and must have been an important food source for Mesolithic groups (Holst 2010).

Molluscs

There was a substantial deposit of sea shells (molluscs) in the upper part of the upper cultural layer, composed largely of northern horse mussels (*Modiolus modiolus*), along with sea snails (*Littorina littorea*), some cockles (*Cardium glaucum*), a few oysters (family Ostreidae), and a small predator snail (*Nassarium pygmaeus*). In places this appeared to have been part of a midden deposit, ca. 20 cm in thickness, with a distribution covering several tens of square meters. On the other hand, this may well be a natural deposit of shells accumulated on a beach, especially since the horse mussels are usually found at a depth of 5 m or more below water surface, beyond ready human access (Comely 1978).

Bone

Preservation at the site of Asnæs Havnemark was very good and the presence of smaller bones as well as larger pieces is a testament to that fact. In addition to a few human remains, there was an exceptional amount of faunal material, including enormous quantities of fish bone. It is important to remember that only a small part of the larger settlement that was originally at this location has been preserved and only a small part of that has been excavated, so that the materials found represent only a tiny part of what would have been present. This material is described in some detail in the following paragraphs and in another publication by Ritchie et al. (2013a). The non-fish fauna study is part of a larger consideration of Mesolithic fauna at a series of sites in Denmark that originally was the PhD thesis of Kurt Gron (2013) at the University of Wisconsin-Madison and has also appeared in a recent publication (Gron 2015).

Human Remains

A fragment of a human mandible with four teeth attached was excavated in unit 122E135N at the site and at least 5 other human teeth were recovered in the excavations. A few small pieces of human bone and tooth were also identified during the sorting and identification of the faunal remains. These materials were

forwarded to the Anthropology collections associated with the Department of Forensic Medicine at the Panum Institute in Copenhagen. The presence of these human remains in the deposits at Asnæs Havnemark strongly suggests that there were Mesolithic burials at the site.

Faunal Remains

The bone material from Asnæs Havnemark was separated by meter square and level during the excavation, bagged, and weighed. In addition, any special finds were noted. There were 131 bags of bone material from 104 different levels and units at the site, for a total of approximately 18 kg. In sum, the faunal material from Asnæs Havnemark consists of 50,005 identified bones. Of these, 47,760 (95.5%) are fish (Pisces), 2214 (4.4%) are mammals (Mammalia), 29 (0.1%) are birds (Aves), and two (< 0.1) common toads (*Bufo bufo*). A total of 799 bones exhibited evidence of burning, including 728 fish bones.

The horizontal and vertical distribution of the faunal remains from the site shows remarkable uniformity. Three layers (culture, shell, and brown) constitute the majority of the vertical provenience information for the samples. The relative abundances of fish from those layers are quite similar, with codfish holding a dominant position of between ca. 75 - 87% of all identified specimens. Overall, all classes of faunal remains from the site show uniformity in their relative abundances across contexts and therefore it is reasonable to treat the assemblage as a unit, as there is remarkably little variability.

Mammals

The identified mammals are listed in Table 1. Identifications were made using the comparative collections at the Zoological Museum Copenhagen (ZMK) and the former Department of Geology and Geography at Copenhagen University. A wide range of species are represented. Numerous long bone fragments are present along with a variety of other bones. For the most part long bone is marrow fragmented. Several species were identified from only a few bones: red squirrel, otter, mouse, wildcat, and two voles. Fur-bearing animals are present in modest numbers. Otter and wildcat are rare, while fox, beaver and pine marten are not uncommon. Marine mammals — seal and porpoise — appear frequently among the

faunal remains. Due to the fact that much of the seal material was not confidently identifiable to species owing in many cases to a lack of diagnostic skeletal elements (e.g. Storå and Ericson 2004), seal specimens were assigned to a general class of “seal”. This class includes the grey seal (*Halichoerus grypus*) and at least one member of the genus *Phoca*.

Table 1. Identified mammal remains.

The identification of mammalian species by skeletal element was tabulated by Gron (2013), along with Number of Identified Specimens (NISP) (after Payne 1975) and Minimum Number of Individual (MNI) statistics. The most common species is roe deer, comprising two-thirds (66.5%) of the identified material, deriving from at least 19 individuals (MNI=19). The next most common individual taxon by NISP is wild boar, making up 6.3% of the assemblage and deriving from at a minimum four individuals (MNI=4). However, taken together, seals (Phocidae), regardless of specific identification, comprise 7.4% of the identified material (MNI=5). They are therefore the second most common mammalian prey. The only domesticated species is the dog, represented by at least four individuals and 5.3% of the assemblage.

A few specimens could be assigned ontogenetic age. One very porous roe deer calcaneus, too young to have even developed epiphyses, probably represents a newborn. Additionally, one wild boar specimen died at around 5 months of age on the basis of a recently-erupted first mandibular molar, and another specimen died under a year of age on the basis of an unerupted second mandibular molar (Matschke 1967). Additionally, the cervical vertebral fusion of a harbor porpoise specimen indicates an animal of at least six years of age (Galatius and Kinze 2003).

In all, the sample cannot provide a mortality profile for any single species at the site although qualitatively, roe deer are represented by animals of multiple ages and therefore there probably was no clear focus on a particular age class indicative of a more specialized procurement strategy (e.g., Richter and Noe-Nygaard 2003).

The preponderance of roe deer in the material is notable, comprising almost two-thirds of the mammalian faunal remains. Body-part representational data indicate that the deer were not butchered elsewhere or selectively transported (Gron 2015)

to the site, an assessment supported by the rather tight distribution of isotopic values (Ritchie et al. 2013) which indicate that these roe deer lived in extremely similar, if not the same, habitats. Despite their high representation in the assemblage however, roe deer were not necessarily the most important species in terms of subsistence. They rarely exceed 25 kg in body-weight (Fruziński et al. 1982), so multiple roe deer are needed even to approximate one red deer carcass, for example.

There are a large number of seal remains and extensive cutmarks on several elements which indicate their utility to the hunters. The location of the site on this peninsula likely explains this as they generally prefer secluded locations when they haul out (Riedman 1990). The seals may therefore have been clubbed while on land at a haul out location near to the site, although hunting with harpoons from boats may have occurred as well.

The location on the Asnæs peninsula may also explain the rather lower numbers of red deer at the site relative to other Ertebølle sites (Enghoff 2011; Gotfredsen 1998; Møhl 1971; Noe-Nygaard 1995; Price and Gebauer 2005; Skaarup 1973), as limited land area may have restricted the numbers of such a large animal (Geist 1998; Kamler et al. 2008). The location would have less affected the abundance of the much smaller roe deer, a species that often lives at higher population densities (Kamler et al. 2008, Gill et al. 1996).

Birds

Bones from a variety of birds are present as well, especially long bones from large birds that appear to have been used in the production of fish hooks. Thirteen species of birds were identified among the avian remains, listed in Table 2. The presence of each species of bird is determined by the find of single or only a few skeletal elements. The birds can be characterized as divers, waterfowl, or birds of prey. A number of these are large birds including the great auk, swan, and eagle. The presence of the great auk (*Pinguinus impennis*) was of interest because this flightless bird, standing approximately 90 cm tall and weighing ca. 5 kg, became extinct in the mid-nineteenth century. Several examples of third phalanges (talons) from birds of prey were also recorded in the faunal remains. Birds probably would have been hunted with nets or bow-and-arrow; likely taken either as a source of

meat (waterfowl) or in the case of birds of prey, to obtain feathers for fletching or for ornamentation, or to use the bone for other specialized purposes (Clark 1948).

Table 2. Identified bird remains

Isotopic Analyses

Bone collagen carbon and nitrogen isotope analyses of the faunal remains were undertaken (Ritchie et al. 2013). The focus of the isotopic studies was on the bones of wild animals and domestic dogs from the site in order to determine the environments from which they were hunted, and as a proxy for human diet (Clutton-Brock and Noe-Nygaard 1990; Fischer et al. 2007; Noe-Nygaard 1988; but see Eriksson and Zagorska 2003). Results are indicated in Table 3.

Table 3. Stable Isotopes of Carbon and Nitrogen from Asnæs Havnemark (from Gron 2015).

All wild animals show values that are within normal ranges for southern Scandinavia (Fischer et al. 2007). The roe deer show highly consistent values, indicative of an herbivorous diet in a very similar, and probably forested environment (Gron and Rowley-Conwy 2017). Given the limited width of the Asnæs peninsula, this may indicate a largely forested environment in the Mesolithic if the deer were hunted nearby. The wild boar have higher $\delta^{13}\text{C}$ values than the deer, but not higher $\delta^{15}\text{N}$. While omnivory cannot be ruled out, this is more likely due to their browsing in more open environments such as open grasslands, feeding in which will elevate $\delta^{13}\text{C}$ values (Gron and Rowley-Conwy 2017). A seal specimen, identified as a grey seal, has much higher $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values, as is expected for a marine carnivore. The dogs' values indicate they were eating an almost entirely marine diet, similar to other Mesolithic dogs from Denmark (Fischer et al. 2007). It is in this context that the aggregate faunal remains need be understood, and in particular the fish.

Fish

A substantial part of the effort of our excavations and analysis involved the fish remains at Asnæs Havnemark, as it was clear that this was a large and important component of the site deposits. Eventually these materials became a focus of a PhD thesis at the University of Wisconsin-Madison (Ritchie 2010) as well as several important publications in Mesolithic studies (e.g., Ritchie et al. 2013a, 2013b). More

detail on the sampling and identification of fish bone appears in the online Supplementary Information.

The identified family and/or species of fish in the bone material from Asnæs Havnemark is listed in Table 4. A total of 47,760 specimens were identified from the three trenches at Asnæs Havnemark, from 18 fish families. The number of unidentified vertebrae in the 4mm fractions is 4.7%, unidentified fishbone 4.2% by weight. The fish assemblage from Asnæs Havnemark is remarkable because of its size and diversity. Codfish dominate the assemblage, with eel following at a distant second and other fishes contributing relatively minor amounts. Freshwater fish are rare (only 8 cyprinid vertebrae), but diadromous fish include eel, shad, and trout/salmon. These results are very much in accord with the site's location on the Asnæs peninsula with no major bodies of freshwater in the vicinity.

Table 4. Identified fish remains (numbers are from the screen-test samples)*

Another important category of evidence regarding the fish remains at Asnæs Havnemark comes from 898 recovered otoliths. Otoliths are small calcium carbonate structures in the inner ear of many vertebrate species. The otoliths were used for estimating fish size and also isotopically analyzed for information on season of death.

Summary data are graphically displayed in Figure 11. Estimates range from cod as small as 20 cm (with a weight of ca. 100 g) up to a maximum of 53 cm (weight ca. 1.5 kg), with an average of around 33-34 cm (weight ca. 300 g). Weights are estimated from similarly sized fish in the comparative collection of AZA in Schleswig, Germany. Estimates of eel sizes ranged from 42 to 86 cm, with an average of approximately 61 cm (obtained from formula in Enghoff 1994). There was not a great deal of variation in the sizes of the flatfish, with an average length of about 25 cm.

The size estimates for the fish are similar to those from other Ertebølle sites in Denmark. Cod usually average around 30 – 40 cm, slightly larger at Lystrup Enge and Grisby. In general, the maximum size of the Asnæs Havnemark gadids is less than seen at other sites, but sizes here were estimated solely with otoliths

and other elements indicate larger fish. There are other elements in the assemblage that indicate larger fish were caught. Eels from the site are similar in size to those seen elsewhere, although the absence of any specimens less than 42 cm is notable. The flatfish from Asnæs Havnemark are also similar in size to those found in other Ertebølle assemblages (Enghoff 1994). The fish bones represent a minimum of hundreds of individuals, demonstrating that fish were a significant part of the diet, even if their precise importance is difficult to ascertain.

Stable isotope analyses of seven cod otoliths from two late Mesolithic Ertebølle sites (Asnæs Havnemark and Fårevejle) were conducted to determine the season of catch for the fish (Ritche et al. 2013b). Results indicate fishing during the late winter, spring and summer. This is a considerably broader fishing season than that estimated solely from the presence of migratory fishes in the assemblages and suggests that fishing played a larger role in the annual subsistence cycle than previously acknowledged.

In regard to the fish, the fact that at least 22 types of fish from 18 different families are present in the assemblage shows that there were many fishes available that the inhabitants could choose to take. While fishes were locally available in higher or lower numbers depending on the species, the many bones of codfish (and to a lesser extent eel) demonstrate that they were the preferred catch. The rocky, exposed shoreline near the site, the predominance of codfish (including large individuals of cod and haddock), and the recovery of numerous fishhooks and preforms suggest that angling (possibly offshore in boats) played a major role in the fishery. This interpretation is supported by the very low incidence (0.1 %), of weever, a species often used as a marker of fishing with stationary structures (Enghoff 1994). A further indication of the importance of the cod fishery is the otolith evidence showing that they were caught at many different times of the year. That most of the eel are larger than 50 cm and thus presumably females, points to eel fishing in the fall when they were migrating from freshwaters into the sea (Muus et al. 2006). Some of the smaller fishhooks could have been used in this fishery, but it is also possible that nets, traps or spears were employed during this event. Access to good cod fishing grounds and migrating eels in the fall may have been the reasons behind why the site is located far out on the Asnæs peninsula, a setting

that was the location of an important historical fishery for several different species (Drechsel & Petersen 1988).

Bone Modification

Burning, butchery, and tool production were all ways that bone at Asnæs Havnemark was modified by human activities. Less than 1% of the mammal material is affected by burning, indicating that most cooking occurred after removal of meat from the bones. Other options involve meat being either cooked (stewing, earth ovens) or preserved (drying, smoking) by methods that would not result in burnt bones. Burning is the principle manner in which the fish remains have been modified, although this was a fairly rare occurrence. Despite the fact that a total of 728 fish bones from the 4 mm sieving assemblage exhibit signs of burning (ranging from partial blackening to complete calcination), this is a small percentage (ca. 1.6%) when considered in the context of over 44,000 identified specimens.

Evidence of butchery (including sawing, cutmarks, scrape marks, etc.) was present on some mammal bones, although any systematic patterns are obscured by the condition of the bone material and their relative rarity. Cutmarks, for example, were observed on only 2.9% of the roe deer specimens, 2.8% of the wild boar specimens, and 1.6% of the red deer specimens. However, nearly all of the appropriate mammal bones were marrow-fractured, and no systematic choice of one species over another is evident. Other than the previously described burning, osteological evidence for how fish were prepared is scant. There were almost no cutmarks observed during the analysis and skeletal element representation provides little additional information about butchery methods.

Bone tools were generally limited to the 43 fishhooks and preforms, along with 6 roe deer antler *retouchoirs*, bone points (5), bone awls (4), bone needles (2), and one tooth pendant. The tooth pendant was made from the reticular canine or grandeln tooth of a red deer (*Cervus elaphus*) shown in Figure 12 (S. Sørensen 2016). The root had been perforated for attachment. Such pendants are often found in graves and perhaps there were some burials at the site.

Figure 12. Grandeln tooth from red deer made into tooth pendant.

The bone fishhooks and preforms were a special category of artifacts from this site (Figure 13). There were a total of 43 fishhooks (25) and preforms (18). These specimens were in various states of preservation, both complete and fragmentary. Several of the preforms exhibited preliminary engraved lines to mark the outline to be cut from the bone.

Figure 13. Some of the fishhooks and preforms from Asnæs Havnemark. The scale is 3 cm.

In general, relatively few bone specimens were worked or prepared for the manufacture of tools. However, one aspect particularly worthy of note is the degree and specificity of working traces found on bones of domestic dog. In total, 119 fragments of bone are attributable to dog. Of this number, nearly every longbone is worked in a very similar fashion, with minor differences probably owing to variations in bone morphology. Regardless of the specific longbone to be worked, the flattest surface was first selected and then incised on either side, to prepare a relatively flat section of cortical bone with parallel edges. Subsequently, the prepared section was incised perpendicular to the edges in order to weaken, and eventually remove, a flat and broadly rectantular piece of bone.

This preparation resulted in a preform for making fish hooks. While the majority appear to be made from the long bones of dogs one of these preforms came from a swan ulna (*Cygnus* sp.). Several of these preforms show the general method of making fishhooks from these flat pieces of bone. Several hooks could apparently be made from one flat piece of bone by hollowing out the curvature of the hook and snapping the nearly complete hook off from the flat piece.

Seasonality

The faunal remains provide a means for examining the seasons of site use at Asnæs Havnemark. Multiple lines of evidence including animal behavioral ecology, oxygen isotope analysis of cod otoliths, and ontogenetic aging of select species indicate use of the site in all seasons of the year. As Sørensen (2017, p. 31) noted, at large coastal settlements from both the Kongemose and the Ertebølle periods all seasons of the year are usually represented in the faunal remains.

The presence or absence of animals at specific times of the year can be a useful tool for establishing the season of occupation at archaeological sites. Seasonal information is restricted to species with migratory patterns. The seasonal information from the birds at Asnæs Havnemark is limited. The golden eagle, mute swan, white-tailed eagle, herring gull, red-breasted merganser, great crested grebe, red-necked grebe, song thrush, and common blackbird (Table 3) are all possibly year-round residents in Denmark (Génsbøl 2006). The osprey only leaves in winter and the whooper swan is only absent in summertime. Red-throated loons seasonally migrate through Denmark in the spring and autumn (Génsbøl 2006). As there is a single specimen for most of these species at the site it probably best not to draw strong conclusions regarding seasonality from this category of evidence.

Migratory behavior is also present in the fish evidence, especially with regards to garfish and mackerel that are present in Danish waters from the late spring to early fall. The presence of bones from both of these species in the assemblage, albeit in limited numbers, strongly suggests summer occupation at Asnæs Havnemark. Three diadromous fishes (eel, shad, and salmon/trout) provide some evidence for site use during spring and fall based on the fact that they are most easily caught during migration, although individuals could also have been taken at other times of the year (Muus et al. 2006).

In contrast with the evidence from migratory fish, the predominance of codfish in the assemblage (including large examples of cod and haddock) may be evidence for winter occupation, based on comparison with the Danish fishery in the 19th century (Drechsel and Petersen 1988, Moustgaard 1987). To test this idea, a pilot study using a newly developed methodology was conducted on four cod otoliths to determine in which season these fish were caught. The method relies on three factors: that fish otoliths grow incrementally throughout the life of the fish, that they incorporate isotopes of oxygen in ratios that reflect their surroundings, and that the ratio of ^{16}O and ^{18}O in their aquatic environment varies in response to water temperatures (see Hufthammer et al. 2010, Ritchie et al. 2013b). By comparing the result from the sample taken from the outer edge of the otolith (the area being formed when the fish died) with the annual cycle of water temperature changes revealed by the complete series of samples, it is possible to determine at what time of year the fish was caught. The 48 cm fish, for example, was caught when water

temperatures were just beginning to warm from their annual low, corresponding to a seasonality indication of late winter or early spring (Figure 14). Although the sample size is small, these results show that while some cod were caught during the summer, winter and spring were also seasons of the fishery at Asnæs Havnemark.

Figure 14. Results from 48 cm long cod. Readings higher (more negative) on the y-axis indicate warmer temperatures and readings farther to the right on the x-axis are closer to the time of capture.

Two lines of evidence are available for the estimation of season of occupation using the mammalian remains; the seasonal casting of antlers by deer, and the ontogenetic development of, in this case, roe deer and wild boar. Modern roe deer cast their antlers in November and December (Sempéré et al. 1992) after which, they grow back in an annual cycle. Several roe deer frontal bones and their attachment points for antlers, the pedicles, are present at Asnæs Havnemark which provide evidence of different stages in this cycle. Uncast antlers still attached to the pedicle, antlers in the process of being cast from the pedicle, and pedicles that have recently cast their antlers are all present in the assemblage. This indicates that the deer in question died at that stage of their life cycle. The recently cast antlers that have not yet started to regrow and the antlers in the process of being cast are therefore very strong indicators of a late autumn, or early winter time of death.

Figure 15 summarizes the cumulative seasonality information from the animal remains. In aggregate, there is evidence for a human presence at Asnæs Havnemark for much of the year with the caveat that visits need not have been continuous. It is, nonetheless, apparent that hunting and fishing took place in similar seasons. It would seem that there is good evidence for year-round use of the site at Asnæs Havnemark, and very strong evidence for human presence in the summer.

Figure 15. Seasonality at Asnæs Havnemark (Dark grey indicates confidence, lighter grey lesser confidence).

Interpretation

The site location, faunal assemblage, and tool technology all point to the conclusion that the people who lived at Asnæs Havnemark oriented their lives towards the sea. Isotopic evidence indicates that seafood was the most important part of the diet, although the relative contribution of marine versus terrestrial foods is not completely clear. The overall impression of animal use at the site is one of both focus and

breadth. In this sense, the diet of the inhabitants appears to be similar to the pattern known from many other Ertebølle sites. While the assemblage is strongly dominated by fish of the cod family and roe deer, there is a wide range of other species present. With availability of these primary food sources ensured, other animals could be incorporated into the subsistence regime as opportunity presented.

There is variability in Ertebølle faunal use that has not generally been recognized. While the same species are generally present in most assemblages, their relative abundance does vary widely among sites. Five other sites from Denmark (Bjørnsholm on the Limfjord in northern Jutland, Vængesø III in east-central Jutland, Tybrind Vig on Funen, Nivågård in northeastern Sjælland, and Smakkerup Huse in northwestern Sjælland) have reasonably large faunal assemblages excavated with methods appropriate for recovering a good sample of fish remains (Andersen 2009, Bratlund 1993, Enghoff 2011, Price and Gebauer 2005). The assemblages from these sites help to demonstrate that broad differences in fishing practices existed within the larger framework of available resources.

Examining the different families of fish at these sites makes it apparent that generally the same types of fish were caught. Despite this exploitation of common species, the fisheries were actually quite variable when relative abundances are considered. At most sites, a majority of the specimens are from one type of fish, but that type varies between codfish, flatfish and eel (most often codfish). The fact that mostly the same types of fish are found at Ertebølle sites throughout Denmark, but in widely varying abundances points to fully competent fishing capabilities tailored to local conditions.

The same pattern is seen with the mammal bone, even if restricted to only Ertebølle sites on Zealand (Figure 16). The same mammals are generally present at these sites. Where dissimilarity does occur, it often can be attributed to the local availability of species. The relative abundance of species is quite different at individual sites. Variability is observed particularly among the three main terrestrial game animals (red deer, roe deer, and wild boar), as well as sea mammals and fur-bearing species. The faunal material from Asnæs Havnemark highlights this variability and underscores the reality of differences among certain classes of resources.

Figure 16. Variation in relative abundance (NISP) of mammal bones from Ertebølle sites on Zealand (Hede 2005; Ritchie et al. 2013, Gron 2013, Gotfredsen 1998; Møhl 1971; Skaarup 1973; Noe-Nygaard 1995).

These comparisons show that within almost all classes of animals exploited by Ertebølle hunters and fishers, there is a great deal of inter-site variability. While the same animals generally occur in all assemblages, the focus of the subsistence at each site represents an adaptation to local conditions. In the case of Asnæs Havnemark, the location of the site may explain to some degree the preponderance of just a few species in the archaeological material. However, a major caveat is that while this is the case, the breadth of species and range of classes of animals utilized remains quite impressive, indicating an ability to employ multiple hunting and fishing strategies to fully exploit local resources. We take this to strongly indicate that in the face of either seasonal or atypical environmental stresses, Ertebølle hunters at Asnæs Havnemark had the knowledge and skills to readily switch between vastly different classes of resources as needed.

Conclusions

The Asnæs peninsula has been associated with fishing for generations. There is an historical fishing village on the south coast of the peninsula with well-known fixed weirs (Pedersen 1997). There are former fisherman's houses and processing buildings 2 km east of the site of Asnæs Havnemark. A herd of seals is still often seen off the west end of the peninsula. The area is also a well-known hunting area and both roe deer and pheasants are taken in large numbers. The peninsula has probably been a resource rich area for millennia.

The site of Asnæs Havnemark is unusual for a number of reasons and has substantial potential to provide information on the transition to agriculture in this region. The radiocarbon dates now available place the second phase of the site occupation at the time of the transition to agriculture in southern Scandinavia, ca. 4000 cal BC. The deposits are terrestrial, rather than waterlain, and a portion of the settlement area is intact. The cultural layer appears to represent a short-term occupation, lying between two episodes of beach ridge formation. Beach ridge deposition at this elevation must have taken place during a time of higher sea level, likely during the Littorina transgression at the end of the Atlantic climatic episode. This event fits extremely well with the radiocarbon dates for the site and also

provides important information on potentially significant environmental changes at the end of the Mesolithic period.

The site is of interest for a number of reasons including the coastal location, the unusual ceramics, the nature of the fishery, and the focus on specific game species. Beyond the normal assemblage of materials that characterize a late Mesolithic site in this region, there are high numbers of stylistically homogeneous projectile points, distinctive flake axes, bone fishhooks and preforms, seal bones, large bird bones, and an extraordinary amount of fish bone at Asnæs Havnemark. The rich occupation layer, including a fragment of a human jaw, suggests a substantial residential settlement on this coast. While a variety of species are represented, eel and cod are very common.

In addition, a large quantity of ceramic material was recovered in the test excavations. This abundance of pottery includes both pointed-bottom vessels and oval lamps from late Mesolithic, as well as several examples of Early Neolithic ceramics. Assuming contemporaneity, the unusual pottery, TRB in tradition, suggests some contact with early farmers either in Denmark, southern Sweden, or across the Baltic in northern Germany. The unusual types of pottery, however, appear to be locally made.

The cod family dominates the fish assemblage, while roe deer account for the vast majority of the mammal remains. Despite the preponderance of these two species of animals, the assemblage presents an impressive variety of other fish, mammals and birds. Different skills and procurement strategies are required to obtain terrestrial game, fur animals, seals, raptors, waterfowl, and the various species of fish. The wide variety of animals represented in the Asnæs Havnemark assemblage indicates that the people who lived there were proficient in a number of different hunting and fishing techniques. The predominance of roe deer in the mammal material and cod in the fish material does indicate a distinct degree of economic specialization. However, it is important to remember that the inhabitants of Asnæs Havnemark were not so much constrained by the availability of animals in the vicinity of the site, as drawn there because of the prey that was present.

Despite the preponderance of roe deer and codfish remains, the Asnæs Havnemark assemblage is the result of a highly flexible hunter-gatherer subsistence strategy able to adapt to local, seasonal, and longer-term shifts in resource availability. In turn, this means that environmental stresses would have less impact to create major changes in general subsistence patterns. As noted earlier, the major lesson that we learned from these excavations concerned the variation that defined the settlements and activities of Late Mesolithic groups.

Because of this flexibility, we contend that substantive environmental changes could not have been the major causal force for the introduction of agriculture at the end of the Ertebølle period. The evidence we have presented greatly weakens such arguments. The abundance of food in the form of marine resources and roe deer found at the site suggests that food stress was not an issue for the local population. Such evidence argues that more food was not an incentive when the Neolithic was introduced in southern Scandinavia.

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Figures

- Figure 1. The location of the site of Asnæs Havnemark toward the tip of the peninsula of Asnæs near the town of Kalundborg, Denmark, looking east. The red arrow marks the site.
- Figure 2. LIDAR image of the location of Asnæs Havnemark along the north coast of the Asnæs peninsula.
- Figure 3. Schematic plan of excavations at Asnæs Havnemark including grid and elevations for the general area of the project.
- Figure 4. Plan of the excavation trenches at Asnæs Havnemark 2007 with shaded meter squares marking the area of intensive excavation.
- Figure 5. Overview of excavations in Trench 3 looking east.
- Figure 6. A distal concave truncated blade knife from Asnæs Havnemark (Årby 365). Length is approximately 71 mm.
- Figure 7. Selected projectile points from various contexts at Asnæs Havnemark (Årby 365).
- Figure 8. Selected flake axes from Asnæs Havnemark (Årby 365).
- Figure 9. Round base of Ertebølle vessel. The label provides a scale, the site name, the meter square provenience, and the layer name.
- Figure 10. TRB pottery sherd, neck-belly transition. The label provides a scale, the site name, the meter square provenience, and the layer name.
- Figure 11. Total lengths of cod for all levels combined.
- Figure 12. Grandeln tooth from red deer made into tooth pendant.
- Figure 13. Some of the fishhooks and preforms from Asnæs Havnemark. The scale is 3 cm.
- Figure 14. Results from 48 cm long cod. Readings higher (more negative) on the y-axis indicate warmer temperatures and readings farther to the right on the x-axis are closer to the time of capture.
- Figure 15. Seasonality at Asnæs Havnemark (Dark grey indicates more confidence, lighter grey less confidence).
- Figure 16. Variation in relative abundance (NISP) of mammal bones from Ertebølle sites on Zealand (Hede 2005; Ritchie et al. 2013, Gron 2013, Gotfredsen 1998; Møhl 1971; Skaarup 1973; Noe-Nygaard 1995).

Tables

Table 1. Identified mammal remains.

Table 2. Identified bird remains.

Table 3. Stable Isotopes of Carbon and Nitrogen from Asnæs Havnemark (from Gron 2015).

Table 4. Identified fish remains (* numbers are from the screen-test samples).

Table 1. Identified mammal remains.

Taxa	Common Name	NISP	MNI
<i>Capreolus capreolus</i>	roe deer	1493	19
<i>Martes martes</i>	pine marten	65	5
<i>Sus scrofa</i>	wild boar	141	4
<i>Canis familiaris</i>	domestic dog	119	4
<i>Erinaceus europaeus</i>	hedgehog	12	4
<i>Cervus elaphus</i>	red deer	122	3
<i>Vulpes vulpes</i>	fox	43	2
<i>Castor fiber</i>	beaver	21	2
<i>Sciurus vulgaris</i>	red squirrel	5	2
<i>Lutra lutra</i>	otter	5	2
<i>Apodemus flavicollis</i>	yellow-necked mouse	4	2
<i>Phocoena phocoena</i>	harbor porpoise	14	1
<i>Felis silvestris</i>	wildcat	2	1
<i>Clethrionomys glareolus</i>	bank vole	1	1
<i>Arvicola terrestris</i>	water vole	1	1
Phocidae	seal	166	5
Totals		2214	58

Table 2. Identified bird remains

Taxa	Common Name	NISP	MNI
<i>Pinguinis impennis</i>	great auk	3	2
<i>Cygnus olor</i>	mute swan	6	1
<i>Pandion haliaetus</i>	osprey	4	1
<i>Haliaeetus albicilla</i>	white-tailed eagle	3	1
<i>Aquila chrysaetos</i>	golden eagle	3	1
<i>Gavia stellata</i>	red-throated loon	2	1
<i>Podiceps grisegena</i>	red-necked grebe	2	1
<i>Cygnus cygnus</i>	whooper swan	1	1
<i>Larus argentatus</i>	herring gull	1	1
<i>Mergus serrator</i>	red-breasted merganser	1	1
<i>Podiceps cristatus</i>	great crested grebe	1	1
<i>Turdus merula</i>	common blackbird	1	1
<i>Turdus philomelos</i>	song thrush	1	1
Totals		29	14

Table 3. Stable Isotopes of Carbon and Nitrogen from Asnæs Havnemark (from Gron 2015).

Number	Species	Lab #	%C	%N	C:N	$\delta^{13}\text{C}$ (‰)	$\delta^{15}\text{N}$ (‰)
AH24-49	<i>Capreolus capreolu:</i>	258926	21.78	7.2	3.53	-23.0	4.8
AH40-19	<i>Capreolus capreolu:</i>	268260	16.41	5.24	3.66	-22.9	5.5
AH74-15	<i>Capreolus capreolu:</i>	268261	18.45	5.82	3.70	-23.1	5.9
AH70-14	<i>Capreolus capreolu:</i>	268262	20.07	6.58	3.56	-22.8	5.8
AH73-16	<i>Sus scrofa</i>	268266	17.24	5.74	3.50	-20.9	5.2
AH-84-1	<i>Sus scrofa</i>	284462	35.46	12.70	3.26	-20.9	5.1
AH70-20	<i>Phoca/Halichoerus</i>	268269	18.88	6.37	3.46	-9.56	14.2
AH85-4	<i>Canis familiaris</i>	268272	15.06	4.88	3.60	-11.9	10.1
AH83-10	<i>Canis familiaris</i>	268273	14.30	4.60	3.63	-13.2	11.89

Table 4. Identified fish remains (* numbers are from the screen-test samples; a version of this table appears in Ritchie et al. 2013a)

Family	Species	Common name	NISP
Anguillidae	<i>Anguilla anguilla</i>	eel	3949/ 598*
Belonidae	<i>Belone belone</i>	garfish	45 / -*
Callionymidae	<i>Callionymus lyra</i>	dragonet	1 / -*
Clupeidae	<i>Clupea harengus</i>	herring	158 / 106*
	<i>Alosa</i> sp.	shad	13 / -*
Cottidae	<i>Myoxocephalus scorpius</i>	bullrout	601 / 96*
Cyprinidae	various	carp family	8 / 2*
Gadidae	various	codfish	38103 / 2244*
Gasterosteidae	<i>Gasterosteus aculeatus</i>	3-spined stickleback	- / 44*
Gobiidae	<i>Gobius</i> sp.	goby	- / 3*
Pleuronectidae	<i>Platichthys flesus</i> / <i>Pleuronectes platessa</i> / <i>Limanda limanda</i>		
		flounder / plaice / dab	897 / 59*
Salmonidae	<i>Salmo</i> sp.	trout/salmon	13 / 2*
Scombridae	<i>Scomber scombrus</i>	Atlantic mackerel	444 / 117*
Scophthalmidae	<i>Scophthalmus</i> sp.	flatfish	1 / -*
Squalidae	<i>Squalus acanthias</i>	spurdog	40 / 1*
Syngnathidae	various	pipefish	- / 1*
Trachinidae	<i>Trachinus draco</i>	Greater weever	34 / 9*
Triglidae	<i>Trigla lucerna</i> / <i>Eutrigla gurnardu</i>	stub / grey gurnard	136 / 5*
Zoarcidae	<i>Zoarces viviparus</i>	viviparous eelpout	18 / 12*
Totals			44461 / 3299*

